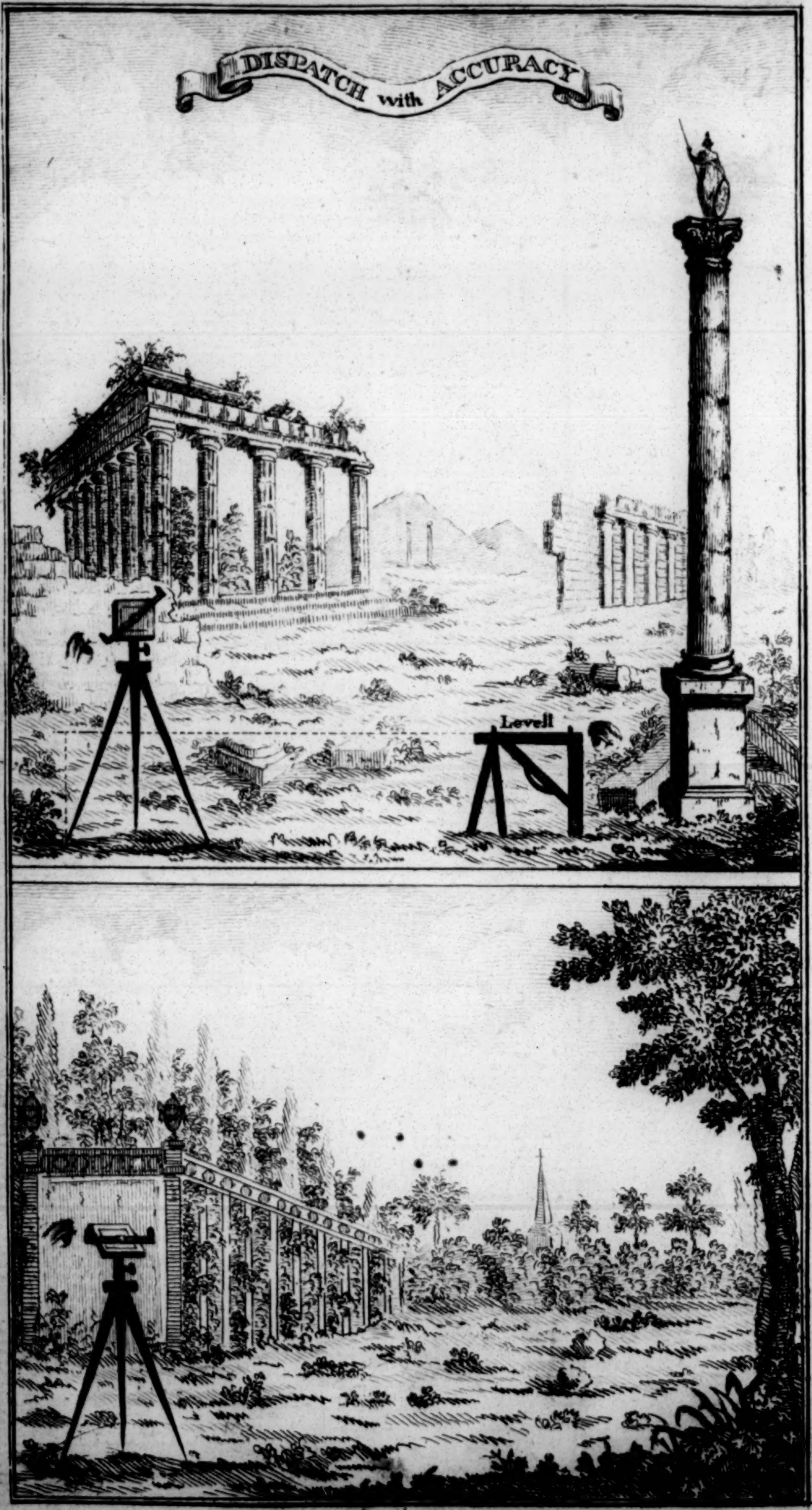

DISPATCH with ACCURACY
Levell

THE
Land-Surveyor's Vade Mecum;
OR,
YOUNG SURVEYOR'S ASSISTANT:

SHEWING.
The readieſt, plaineſt, and trueſt
METHODS,
For the Meaſuring and Mapping all ſorts of LANDS and WATERS; the Planning of BUILDINGS; Plotting or Laying out of GROUNDS; the taking of HEIGHTS and DISTANCES; the Tracing and Laying down any ANGULAR FIGURES whatever,

BY THE
UNIVERSAL PLANE TABLE.

This Inſtrument for the Smallneſs of its Size, and the Certainty of its Uſe, is preferable to any other Inſtrument yet invented; and will be ſound of the greateſt Utility to all Perſons concerned in the SURVEYING of LAND, and in the MILITARY ARCHITECTURE, &c.

TO WHICH ARE ADDED,
All the RULES and TABLES proper ſor the taking and caſting up a SURVEY, the purchaſing of LEASES, &c.
With ſeven Copper-Plates, explaining the particular Problems, &c.

By MICHAEL SEARLES, LAND-SURVEYOR,
Of GREENWICH, in KENT.

(Price bound Two Shillings and Six-pence.)

To be had of the Inventor, ~~and of Mr. Cole, No. 136, Fleet-Street, London.~~

Of whom likewiſe may be had,
His New-Invented PORTABLE LEVEL, ſuited to the Uſe of Artificers in Building, Gardening, Roads, &c.

Price of the TABLE —— —— ——		£2	2	0
————	with Staff, Ball, and Socket	£3	5	0
Price of the LEVEL —— —— ——		£1	1	0

Printed for the AUTHOR:
And Sold by the BOOKSELLERS in Town and Country,

CONTENTS.

CHAP. I.

DECIMAL ARITHMETIC.

1. Reduction
2. Addition
3. Subtraction
4. Multiplication
5. Diviſion

} of DECIMALS.

6. Extraction of the Square Root.

CHAP. II.

GEOMETRICAL PROBLEMS.

1. To erect or let fall a Perpendicular.
2. To divide a Right Line in two equal Parts.
3. To draw Lines Parallel.
4. To divide a Line into any Number of equal Parts.

CHAP. III.

GEOMETRICAL DEFINITIONS.

1. Of a Plain
2. Of an Equilateral
3. Of an Iſoſceles
4. Of a Right
5. Of an Oblique

} TRIANGLE.

6. Of four-ſided Figures.
7. Of Scales and Chains.
8. A Table of Long Meaſure.
9. A Table of Square Meaſure.
10. A Table of Feet, Chains, and Links.
11. A Table for a Square Acre.

CHAP. IV.

Of Menſuration, with the Conſtruction of plain Figures and their Meaſurement.

CHAP. V.

Deſcription of the Univerſal PLANE TABLE.

1. Its uſe in taking a Plan of a Field, &c.
2. In taking a Plan from a fixed Station.
3. To take the Curviture or Bend of a Field.

A Deſcription of the Field Book.

4. To take the Diſtance of an acceſſible Object.
5. To meaſure an acceſſible Height.
6. To meaſure any inacceſſible Height.
7. To lay down or trace any Angular Figures.
8. To enlarge or diminiſh a Plan.
9. To find the Meridian of any Plain.
10. Its uſe as a Quadrant—for the Elevation of a Line, &c.

CHAP. VI.

A Table for the Purchaſing of Leaſes.

1. The true Method to find the Value by the Table.
2. To find what Sum muſt be received per Annum, for any Sum of ready Money paid for a Term of Years.
3. The Characters or Signs made uſe of in Arithmetic.

BRITISH MU

To the READER.

HAVING for upwards of twenty years been in the practice of Land-Surveying, and uſed the ſeveral Inſtruments that are now extant, for the performance of that art, I always found a difficulty in the cloſing of a ſurvey (from the uncertainty of the needle's variation, and the errors of a graduated Inſtrument) with that accuracy, as the nature of a Survey requires. And having ſeen a ſmall Treatiſe, giving the deſcription of an Inſtrument, invented by the late Brigadier General DOUGLASS, which Inſtrument was greatly approved of by that renowned Engineer, the Baron DE COEHORN (under whom he ſerved); I immediately ſet about the making of the Inſtrument, which when done, I found it too compound for general practice: but as the principle was founded upon the infallible axioms of the Mathematics, and the Solution plain and eaſy; I, therefore, from the ſame Principle, invented this my Univerſal Plane Table; which Inſtrument, for the certainty of its uſe, and the quick diſpatch in taking and laying down a Survey, is preferable to any other, as the angles, if carefully taken, will cloſe the Survey to the greateſt exactneſs; and the laying of it down being performed by a T ſquare, or parallel rule, cannot vary. The taking of Heights and Diſtances by this Table is not by degrees or minutes, the angle being drawn from the obſervation; ſo that the height or diſtance of any object is found by the moſt plain and eaſy method, as will be ſhewn in this Treatiſe. I have alſo added an Index to the Table, whereby the height of a Tree, &c. may be known at one view, by the taking the diſtance, which is ſuppoſed to be divided into 10 or an 100 equal parts. And to make this book of the greater uſe, I have added the plain rules of Decimal Arithmetic, the Extraction of the Square Root, and ſuch Geometrical Problems as are uſeful for the more ready caſting up the contents of a ſurvey: alſo all thoſe tables requiſite for helping the memory in the practice of ſurveying. I conclude, with wiſhing the reader may find as much pleaſure in the trial of this Inſtrument, as I have had ſatisfaction in the conſtant uſe of it.

The Portable Level is compoſed of three pieces of mahogany, forming a right angle, the legs being about 3 feet 4 inches; on the diagonal is fixed a braſs ſegment, divided into inches and parts, which ſhews at one view how much the line, &c. is elevated or depreſſed, and when uſed for diſtance is ſupported by two legs, fitted for that purpoſe. [*See frontiſpiece.*

THE

Young Surveyor's Aſſiſtant, &c.

CHAP. I.

Of Decimal Arithmetick.

AS Decimal Fractions are the only method whereby the contents of land or other ſuperficies may be found, and alſo the moſt ready way for performing all kind of menſuration, it will be proper in this Treatiſe to give ſome few examples for the performing the ſame.

And firſt: the nature of a Decimal Fraction may be conceived by a foot rule, ſuppoſed to be divided into ten equal parts, and each of thoſe parts to be divided into ten equal parts; then is the foot, yard, or any other meaſure, divided into 10, or 100, or 1000 equal parts; and in this manner we conceive the foot, yard, pole or chain to be divided.

The Decimal Fraction is diſtinguiſhed from the whole number by a point, or comma, as thus, ,5 is $\frac{5}{10}$, ,25 is $\frac{25}{100}$, and ,386 is $\frac{386}{1000}$.

PROBLEM I.

To reduce a Vulgar Fraction into a Decimal Fraction.

THE rule: annex to the numerator a number of cyphers; let this be a dividend, and the denominator the diviſor; the quotient is the Decimal Fraction ſought; if there be a remainder, annex cyphers to bring it to a greater exactneſs.

EXAMPLES.

Reduce $\frac{1}{4}$. $\frac{1}{2}$. $\frac{3}{4}$ and $\frac{5}{8}$ into Decimals.

Ex. I. $\frac{1}{4}$ numerator. denominator.
4) 100 (, 25
8
——
20
20
——
. .

Ex. II. $\frac{1}{2}$ numerator. denominator.
2) 100 (, 50
10
——
. 00

Ex. III. $\frac{3}{4}$
4) 300 (, 75
28
——
. 20
20
——

Ex. IV. $\frac{5}{8}$
8) 500 (,625
48
——
. 20
16
——
40
40
——
. .

PROBLEM II.

ADDITION of Decimal Fractions is the ſame as whole numbers when the places of the ſame denomination are ſet under one another, as in the following examples.

Ex. I.	Ex. II.	Ex. III.
, 854	1,693	25,640
, 329	4,290	1,398
, 604	,164	,029
1,787	6,147	27,067

PROBLEM II.

SUBSTRACTION. Place the figures as before directed, thus:

Ex. I.	Ex. II.	Ex. III.
, 8492	3,6942	45,687
, 3681	. 1087	30,346
, 4811	3,5855	15,341

PROBLEM IV.

MULTIPLICATION is the ſame as whole numbers, only obſerving in the product to ſeparate with a comma ſo many figures to the right hand as there are fractional parts in the multiplicand and multiplier; the figures on the left hand making whole numbers, and thoſe on the right decimal fractions.

Ex. I.	Ex. II.
4,56	21,04
·63	19,36
1368	12624
2736	6312
	18936
2,8728	2104
	407,33,44

Note. By theſe rules are the contents of land found, as chains and links are ſet down in the ſame manner, that is 21,04 and 19,36, are twenty-one chains four links, and nineteen chains thirty-ſix links; the product is four hundred ſeven chains, thirty-three links, and .44 hundred parts of a link, which is near half a link.

N. B. A chain being 4 poles or 66 feet in length, and divided into 100 links, then 1 link is 100th part of 66 feet: thus,

In.
66 feet × by 12 inches ÷ 100 = 7,92 = one link.
Vide 66 feet
12 inches
100) 792,00 (—7,92 = one link
920
200

PROBLEM V.

DIVISION of Decimals is the ſame as whole numbers, only in the quotient ſeparate with a comma as many Decimals to the right hand for a Decimal Fraction as there are fractional parts in the dividend more than the diviſor.

Example I.

$$\begin{array}{r} 4,5)\ 113,85\ (25,3 \\ 90 \\ \hline 238 \\ 225 \\ \hline \cdot 135 \\ 135 \\ \hline \cdot\ \cdot\ \cdot \end{array}$$

Example II.

$$\begin{array}{r} 2,65)\ 50,1645\ (18,93 \\ 265 \\ \hline 2366 \\ 2120 \\ \hline \cdot 2464 \\ 2385 \\ \hline \cdot\cdot 795 \\ 795 \\ \hline \cdot\ \cdot\ \cdot \end{array}$$

Thus by the preceding examples, it is plain, that Decimal Arithmetick is the ſame as whole numbers, only by obſerving the whole from the fractional parts.

PROBLEM VI.

AS it may be required to prove by Arithmetick the truth of Geometrical Projections, it will be requiſite to give the rule for Extraction of the Square Root, which is no more than to find a number multiplied into its ſelf, ſhall produce the number given. The rule point over the figure on the right hand, and then miſs a figure, and point on till you have pointed all the figures; then find the root of the figure or figures on the left hand, and ſet it down as part of the quotient, which being multipled into itſelf, ſet it down under the firſt point, and ſubſtract; then to the remainder bring down the other two figures of the next period; next double your quotient as a new diviſor, and try how oft you can get this new diviſor out of your laſt dividend, ſetting down both in your quotient and diviſor the number of times you can get this new diviſor; then multiply the diviſor by the laſt found figure in the quotient, ſetting down the product under the laſt dividend, and ſubſtract, and ſo proceed to the end.

EXAMPLE I.

```
          . . .
         61504 ——————— (248 root
         4                248
        ———              ———
    44) 215              1984
        176               992
        ———              496
   488) .3904            —————
         3904            61504 proof
        ——————           —————
         ....
```

EXAMPLE II.

```
          . . . .
         1580,0625 (39,75 root
         9
        ———
    69)  680
         621
        —————
   687) .5906
          5509
        ——————
  7945) .39725
          39725
        ———————
          .....
```

CHAP.

CHAP. II.

GEOMETRY PROBLEMS.

PROBLEM I.

To erect a perpendicular from a point on a given line.

LET the given line be A B, fig. 1, plate 2, and from the point C erect the perpendicular C D; ſet one point of your compaſſes in C, open to any diſtance, and mark d and e equal diſtances from the point C; then open your compaſſes, and placing one foot in d, draw the arch g g with the ſame diſtance; one point in e, mark the arch a a, and where they interſect draw the line D C, the perpendicular required.

PROBLEM II.

To erect a perpendicular on the end of a line.

LET the given line be A B, fig. 2, from the end B to erect the perpendicular B C; open your compaſſes to any diſtance, placing one foot in B, and with the other make the arch d e; the point reſting in d, mark the arch in f; the point reſting in f, mark the arch g h; then draw a line from d through f to cut the arch g h in C; draw the line C D for the perpendicular required.

PROBLEM. III.

To let fall a perpendicular from any point aſſigned upon a right line given.

LET the line given be A B, fig. 3, and the point given D; open your compaſſes to any diſtance more than the perpendicular height, ſetting one point in D, mark the line A B in d and e; then ſetting one point in d, make the arch a b, with the ſame diſtance; one point in e, make the arch g f, and from where they interſect draw the line D E, for the perpendicular required.

PROBLEM IV.

To biſect or divide a right line into two equal parts.

LET the line given be A B, fig. 4; open your compaſſes to any diſtance more than the middle; ſetting one point in A, make the arch d e with the ſame diſtance; ſetting the point in B, make the arch g h, which will interſect in D and C; draw the line D C, which will cut the line A B in E, the middle of the line required.

PROBLEM V.

To draw a line parallel to a given right line.

LET the line given be A B, fig. 5; open your compaſſes to the diſtance required; ſetting one point in a, make the arch c d; then place the point in b, make the arch e f; draw the line C D to touch the top of the arches c d and e f; then will C D, be parallel to A B, as required.

PROBLEM VI.

To divide a right line given into any number of equal parts.

LET the line given be A B, fig. 10, to be divided into five equal parts; from the end A, draw the line A D at any diſtance; then with your compaſſes one point in A, deſcribe the arch d e, and with the point in B, deſcribe the arch a b; then taking the diſtance d e, ſet it on a b, and draw the line B C, then will A D be parallel to B C; then ſet off the number of parts wanting, one on each line, A B and B C, and draw the lines 1.4 and 2.3, and 3.2 and 4.1, ſo will the line A B, be divided into five equal parts, as required.

CHAP. III.

GEOMTERICAL DEFINITIONS OF TRIANGLES.

1. A Plain Triangle is a figure, whoſe area is contained within the limits of three right lines, called ſides, including three angles, and it may be divided, and takes its name either according to its ſides or angles.

By its ſides.

2. An Equilateral Triangle, is that which hath all its three ſides equal, as the figure 9, plate 1.
3. An Iſoſceles Triangle, is that which hath only two of its ſides equal, as the figure 13.

4. An Oblique Triangle, is that which hath all its three ſides unequal, as the figure 12.
5. A Right Angled Triangle, is that which hath one right angle; that is, when two of its ſides are perpendicular to each other, as fig. 8.—C B is perpendicular to A B; therefore the angle at B is a right angle.

Of four ſided figures.

1. A SQUARE, is a plain regular figure, (as fig. 6) whoſe area is limited by four equal ſides, all perpendicular one to another; that is, when A B, B C, C D, D A, and the angles A B, C D, are all equal; then it is uſually called a Geometrical Square.
2. A Rectangle, or a Right Angled Parallelogram, (often called an Oblong, or long Square) is a figure that hath four right angles, and its two oppoſite ſides equal, as figure 7.
3. A Trapezia, is a four ſided figure, whoſe oppoſite ſides and oppoſite angles are unequal, as the figure 11.
4. A right line drawn from any angle, in a four ſided figure, to its oppoſite angle, is called a Diagonal Line, and will divide the area of the figure into two triangles, being denoted by the dotted line in the laſt figure.

Of ſcales and chains.

FOR the more ready laying down of lines according to the obſervation made, it is proper to have a ſcale of equal parts, as fig. 14, plate 2;

alſo the plotting ſcale, fig. 15, which may be about nine inches long, and three quarters of an inch wide; and may be made of box or ivory, divided on the edge into equal parts; that is, to ſuppoſe the foot, or chain, to be divided into ten equal parts, and one of thoſe parts divided into ten equal parts, then the diviſion is 10, 100, or 1000, according to the ſize of the plan to be drawn; the advantage of the plotting ſcale is, that the length may be laid down without the compaſſes; and if taken in feet and inches, the other edge ſhews the length in chains and links; and, if taken in chains and links, the reverſe.

The chain in general uſe is Mr. Gunter's chain, which is 66 feet in length, and is divided into 100 links, each link is 7,92 inches; this chain has marks at every ten links, and a ſmall braſs ring at every five links, for the more ready numbering the links; there are alſo box tapes painted with chains and links on one ſide, and feet and inches on the other ſide, very convenient for to carry in the pocket.

It would be requiſite to be provided with an off-ſet ſtaff, divided into ten links, for the more ready meaſuring the off-ſets from the chain, (as will be ſhewn hereafter) alſo ten ſmall ſticks, or arrows, for the numbering the chains when ſurveying.

You muſt alſo be provided with a T ſquare, with a moveable head, to take off the lines from your paper of obſervation, as fig. 4, plate 1.

Of the ſeveral ſorts of Tables uſeſul in the more ready caſting up the contents of a Survey, or meaſuring of any Superficial Figure.

TABLE I.

ENGLISH LONG MEASURE.

Inches							
7,92	~~7,92~~ 1	Link					
12	1,515	Foot					
36	4,56	3	Yard				
198	25	16,5	5,50	Pole			
792	100	66	22	4	Chain		
7920	1000	660	220	40	10	Furlong	
63360	8000	5280	1760	320	80	8	Miles

TABLE II.

ENGLISH SQUARE MEASURE.

Shewing how many ſquare inches, links, feet, yards, poles, and chains, are contained in one ſquare acre of land.

Inches						
62,726	Links					
144	2,295	Foot				
1296	20,755	9	Yards			
39204	625	272,25	30,25	Poles		
627264	10000	4356	484	16	Chain	
6272640	100000	43560	4840	160	10	Acre

By this table you may plainly ſee that

In one ſquare acre there is contained			
	6272640	Square	Inches
	100000		Links
	43560		Feet
	4840		Yards
	160		Poles
	10		Chains.

TABLE III.

This Table ſhews how many feet, and parts of a foot, are in any number of chains and links, between five links and ſeven chains.

Links	0	1	2	3	4	5	6
0	Feet	66,00	132,00	198,00	264,00	330,00	396,00
6	3,96	69,96	135,96	201,96	267,96	333,96	399,96
10	6,60	72,60	138,60	204,60	270,60	336,60	402,60
15	9,90	75,90	141,90	207,90	273,90	339,90	405,90
20	13,20	79,20	145,20	211,20	277,20	343,20	409,20
25	16,50	82,50	148,50	214,50	280,50	346,50	412,50
30	19,80	85,80	151,80	217,80	283,80	349,80	415,80
35	23,10	89,10	155,10	221,10	287,10	353,10	419,10
40	26,40	92,40	158,40	224,40	290,40	356,40	422,40
45	29,70	95,70	161,70	227,70	293,70	359,70	425,70
50	33,00	99,00	165,00	231,00	297,00	363,00	429,00
55	36,30	102,30	168,30	234,30	300,30	366,30	432,30
60	39,60	105,60	171,60	237,69	303,60	369,60	435,60
65	42,90	108,90	174,90	240,90	306,90	372,90	438,90
70	46,20	112,20	178,20	244,20	310,20	376,20	442,20
75	49,50	115,50	181,50	247,50	313,50	379,50	445,50
80	52,80	118,80	184,80	250,80	316,80	382,80	448,80
85	56,10	122,10	188,10	254,10	320,10	386,10	452,10
90	59,40	125,40	191,40	257,40	323,40	389,40	455,40
95	62,70	128,70	194,70	260,70	326,70	392,70	458,70

To prove the ſame by arithmetick, this is the rule, multiply the chains and links together as one whole number, by 66, cutting off from the product the two laſt figures on the right hand; ſo will the remaining product be feet, and the two figures cut off be parts of a foot, which multiplied by 12, gives the inches; always remembering, that if the links be leſs than 10, to place a cypher before the number, as 2,05 is two chains, five links.

EXAMPLE I.

8,24
66
4944
4944
543,84
12
10,08
feet in
543—10

EXAMPLE II.

19,03
66
11418
11418
1255,98
12
11,76
feet in
1255—11—¾

EXAMPLE III.

2,25
66
1350
1350
148,50

EXAMPLE IV.

7,92 one link
55 links
3960
3960
12) 435,60
36,30

TABLE IV.

Sheweth what breadth is required to any length in rods, from one to forty, to make one acre of land.

Length.	Bread.	Length.	Bread.	Length.	Bread.	Length.	Bread.
40	4	30	$5\frac{1}{3}$	20	8	10	16
39	$4\frac{4}{39}$	29	$5\frac{5}{29}$	19	$8\frac{8}{19}$	9	$17\frac{7}{9}$
38	$4\frac{4}{19}$	28	$5\frac{5}{7}$	18	$8\frac{8}{9}$	8	20
37	$4\frac{12}{37}$	27	$5\frac{25}{27}$	17	$9\frac{7}{17}$	7	$22\frac{6}{7}$
36	$4\frac{4}{9}$	26	$6\frac{2}{13}$	16	10	6	$26\frac{2}{3}$
35	$4\frac{4}{7}$	25	$6\frac{2}{5}$	15	$10\frac{2}{3}$	5	32
34	$4\frac{12}{17}$	24	$6\frac{2}{3}$	14	$11\frac{3}{7}$	4	40
33	$4\frac{28}{33}$	23	$6\frac{22}{23}$	13	$12\frac{4}{13}$	3	$53\frac{1}{3}$
32	5	22	$7\frac{3}{11}$	12	$13\frac{1}{3}$	2	80
31	$5\frac{5}{31}$	21	$7\frac{13}{21}$	11	$14\frac{6}{11}$	1	160

To prove the table the rule is: divide 160, the number of rods in one ſquare acre by its propoſed length, and the quotient is the breadth thereof.

EXAMPLE

EXAMPLE.

Let the length given be 32 rods; then

```
32) 160 (5 rods in breadth is required to
    160     make an acre.
    ---
    000
```

CHAP. IV.

OF MENSURATION.

MEASURING is the art of finding the contents or quantity of any magnitude by ſome given dimenſions that is like it, as a line is meaſured by a line of inches, feet, yards, poles, &c. a ſolid is meaſured by a ſolid inch, foot, or yard, &c. ſo that when you know how many lineal inches, feet, yards, poles, &c. are contained in a line; or how many ſquare inches, feet, or yards, &c. are contained in a ſuperficies; or how many ſolid inches, feet, or yards, &c. are contained in a ſolid; then is the contents of either of theſe magnitudes ſaid to be known. Other dimenſions beſides theſe are not in nature, for length, breadth, and depth, includes all ſpace or capacity; hence, it is evident, that every magnitude muſt be meaſured by its like magnitude; that is, length by lineal inches, feet, yards, &c. ſuperficies by ſquare inches, feet, yards, &c. and ſolids by ſolid inches, feet, yards, &c.

Note { 12 inches is a lineal foot.
144 ſquare inches is a ſuperficial foot.
1728 ſolid inches is a ſolid foot.

On the Conſtruction of the plane figures and their meaſurement.

PROBLEM I. Fig. 1. Plate 3.

TO make a geometrical ſquare, whoſe ſide ſhall be equal to a given line, as A B 40 feet; draw the line A B, and from your ſcale of equal parts take off 40 to the ſide you intend to draw the ſquare; raiſe the perpendicular B C, and with the length A B, mark the perpendicular in C; and with one point in C, make the arch a b; then, with the point in A, mark the arch a b in the point D, and draw the lines A D and D C. To find the contents of all ſquares or parallelograms, the rule is, multiply the length into the breadth.

PROBLEM II. Fig. 2.

TO make a parallelogram, whoſe longeſt ſides is A B 50, and ſhorteſt ſide B C 30, proceed as directed in the geometrical ſquare.

PROBLEM III. Fig. 3. Plate 2.

TO deſcribe a right angle triangle, whoſe ſides A B=43 and B C=36; and to find the length of the hypothenuſe A C; draw the line A B to the length given; erect the perpendicular B C, and mark the length B C; draw the line A C for the hypothenuſe; then with your compaſſes, take the length of the line A C, and apply it to the ſcale you took the length of the lines A B and B C from, and it will ſhew the meaſure required. To find the ſame arithmetically, multiply the ſides A B and B C into themſelves; and from the ſum of the two products, extract the ſquare root, (as ſhewn Chap. I. Problem 6) the root will be the ſide required.

EXAMPLE.

43=A B
43
———
129
172
———
1849
———

36=B C
36
———
216
108
———
1296
1849
———
3145 (56=A C
25
———
106) . 645
636
———
. . 9

The area of all triangles is equal to half their circumſcribing parallelograms, as fig. 3, plate 3; and is found by multiplying half the perpendicular by the whole baſe, or half the baſe by the whole perpendicular.

EXAMPLE.

EXAMPLE.

Baſe A B 43 the perpendicular B C 36
18 one half 18

344
43

744 the area of fig. 3, plate 2.

PROBLEM IV.

To deſcribe an equilateral triangle, as fig. 4, *and to find the length of the perpendicular.*

LET the ſide of the equilateral triangle be A B 45; draw the line A B to the length given, and with one foot of your compaſſes in the point A, mark the arch a b; and with the other foot in B, mark the arch in C, and draw the line A C and C B; then from the point c, let fall the perpendicular C D, (as ſhewn Chap. II. Prob. 3;) then with your compaſſes take the length of the line A C, and apply it to your ſcale, you have the length required; the area is found as before directed, Problem 3.

PROBLEM V.

To deſcribe an oblique triangle, as fig. 5.

LET the three ſides given be

A B=55
B C=48
A C=35

draw the line A B to the length given; then with the length of the ſides B C, one foot in B, mark the arch a b; and with the length of the ſides A C, one foot in A, biſect the arch a b in C, and draw the lines A C and B C the perpendicular height, and the area of the triangle is found as before directed.

PROBLEM VI.

To deſcribe a trapezia as fig. 6.

LET the diagonal be A B=60
Side A C=26
Side C B=50
Side B D=33
Side A D=46

draw the line A B to the length given then, as ſhewn in the laſt Problem; deſcribe the triangles A D B and A C B, and find the length of the perpendiculars C a and D b, as before directed. To find the area, add the two perpendiculars together; that ſum, multiplied by half of the diagonal, gives the area.

CHAP. V.

HAVING in the former Chapters, given the principal rules and tables, with the deſcription of all ſuch plain figures as are likely to be met with in the ſurveying of, (or laying out) lands, I next proceed to give a deſcription of the UNIVERSAL PLANE TABLE, with its uſe.

This table is about five inches ſquare, and is made of mahogany, or any wood that is well ſeaſoned, and conſiſts of two parts, the table and frame; the frame being uſed to keep tight the paper of obſervation when in uſe; in the center of the table is a ſcrew, on which the index, with its ſights, turns, and is faſtened after taking the obſervation.—The table may be fixed to the head of any three legged ſtaff, or to the head of a walking cane, for the taking of ſuperficies, or diſtances of objects, as fig. 1, plate 1; but, when uſed for taking of altitudes, or levels, ſhould be fixed to a ſtaff with a ball and ſocket, for the more ready turning it vertically for uſe; the ſpirit level being on the upper limb of the frame, as fig. 2, plate 1. The table being thus fixed, the line a h is the baſe, and the line c h the angle of altitude.

PROBLEM I.

The uſe of the inſtrument to take the plan of any field, or of any other ſuperficie.

LET fig. 1. plate 4, be the plan required. Having covered your table with a clean piece of writing paper, and fixed on your frame, put on your index with its ſights; then placing marks at each corner of your field, place your table at the angle A; direct your ſights to the mark at E, for your firſt line, and with your pencil draw the line 1; then turn your index till you ſee the mark at B; meaſure the length of the line A B; ſuppoſe 5,00 chain, and ſet it down in your book; ſcrew faſt the Index: having marked the line 2, and meaſured it, move your table to B; unſcrew the table, (the index being faſt) and turn it till you obſerve your laſt ſtation at A; ſcrew your table faſt, then will the index be in a direct line from B to A; unſcrew the index, and direct the ſight to C, and draw the line 3; make faſt the index, and meaſure the line B C; move your table as before directed to C; your index being in a ſtraight line from C to B, turn your index till you ſee the mark at D; draw the line C D, and meaſure it; ſcrew faſt your index, and move your table to D; then turn your table till you ſee the mark at C; then ſcrew it faſt, and direct your ſight to E; draw the line D E, which line, when laid down, will interſect the line A E in E; thus will your obſervation be finiſhed, and you have all the ſides of the field on your paper of obſervation, marked 1.2.3.4.5, fig. 2. Take off your paper, place it at one end of your drawing board, as fig. 3; the paper you intend for the plan being made faſt with a wafer, begin with your T ſquare, and take the line 1, and draw the line A E; move your ſquare to the line 2, and draw the line A B, ſetting off the length with the plotting ſcale, or compaſſes, from your ſcale of equal parts, to the ſize you can conveniently take on your paper, and ſo proceed for all the other ſides, the line 5 meeting in the point E; the length of which ſides is found by applying your plotting ſcale, or taking them with your compaſſes, and applying to the ſcale of equal parts you made uſe of for the plan; ſo will your field be cloſed with the greateſt exactneſs.—To find the contents of the above field, it muſt be divided into triangles,

by

by drawing the diagonals B E and B D, and finding the perpendicular height, as ſhewn Chap. 6, Prob. 3.—To caſt up the contents of the aforementioned field: having meaſured with your plotting ſcale, or with your compaſſes from the ſcale of equal parts, the length of the diagonal lines B E and B D, and the three perpendiculars A e, D e and C g, ſet them down as,

	C. L.		C. L.
B E	6—20	A E	2—30
B D	5—20	D E	2—00
		C g	0—80

To find the Area.

Add the two perpendiculars A e and D e together, and multiply that ſum by half the diagonal B E, will give the area of the two triangles A B E and B D E; then half the diagonal B D, by the whole perpendicular C g, will give the area of the triangle B C D, which added to the other ſum, is the area of the whole field.

EXAMPLE.

B E 6,20	A e—2,30	B D—5,10
——	D e—2,00	——
½ B E=3,10	——	½ B D=2,55
A e + D e = 4,30	4,30	C g=, 80
——		——
9300		2,0401
1240		
——		
13,3300		
2,0400		
——		
15,3700 area of the field.		
——		

which ſum to reduce into acres, cut off one figure from the whole numbers, the remaining figures on the left hand will be acres; then multiply by 4 for roods, and by 40 for poles, the remainder will be the decimal parts of a pole.

EXAMPLE.

$$\begin{array}{r} 1{,}5{,}37 \\ 4 \\ \hline 2{,}148 \\ 40 \\ \hline 5{,}920 \\ \hline \end{array}$$

which ſhews the area of the field to be
A R P
1=2=5 and $\frac{92}{100}$, which is very near one pole.

PROBLEM II. Fig. 4 and 5.

TO take a plan of the ſaid field from any fixed ſtation, place your table in any part of the field, ſuppoſe at o; then with your index and ſights make the obſervation to the angles A B C D E, drawing the lines 1 2 3 4 5, and meaſuring the lengths of the ſaid lines with your chain; then taking off your paper of obſervation, and as before taught, fix it to the drawing board; draw the lines 1 2 3 4 5, and marking off their lengths, draw the lines a b c d e, ſo will you have the true projection of the field; and by the ſame method, it may be taken from any angle of the field, and with the quickeſt diſpatch.—If there are more lines on your paper of obſervation than you can eaſily diſtinguiſh by the interſection, you may ſhift your paper by making the laſt line in the firſt paper the firſt in the ſecond.

PROBLEM. III.

To take the curvature or bend of any field, either within or without the field.

LET the ſides of the field be A and B, fig. 6, plate 4, and a lane between the two fields: firſt, rule your book with a double line in the middle to ſet down the lengths of the ſtations, and the remarks on each ſide; place your table at the beginning of the lane at ſtation 1; then directing your ſights to ſtation 2, ſcrew your index, and draw the line 1; then meaſure from each ſide of your ſtation to the hedge, ſetting down the diſtance, that on the right hand on the right of your book, and that on the left hand on the left of your book, which is ,30 links on the right, and 20 links on the left; then directing the chain in a ſtraight line to ſtation 2, I find a bend on the left hand at $\overset{C}{1}—\overset{L}{20}$ which I ſet down, and meaſuring off each ſide of the chain, write againſt that length, and then proceed with the chain till I come to a gate, which is $\overset{C}{2}—\overset{L}{10}$ from the ſtation which I ſet down, and the diſtances from the gate and hedge, and meaſure again to $\overset{C}{3}—\overset{L}{50}$ ſetting down as before, and then go on to the mark 2, or ſecond ſtation 6—40 which is the whole length of the firſt line, taking the off-ſets as before; then moving the table as before directed to the ſecond ſtation, proceed till you have finiſhed.

Note. If the off-ſets are long, the box tape is proper; or if ſhort, the off-ſet ſtaff as mentioned Chap. 4, will be moſt uſeful; always obſerving to take your off-ſets ſquare from your chain.

FIELD BOOK.

Beginning at the LANE.

REMARKS.	Links.		Links.	REMARKS.
to hedge	,20	Sta. 1	,35	to hedge
to hedge	,30	1, 20	,54	to hedge
to gate	,82	2, 10	,10	to hedge
to hedge	,40	3, 50	,58	to gate
to hedge	,20	6, 40	,52	to hedge
		Sta. 2		

PROBLEM IV.

To take at two ſtations any inacceſſible objects.

LET the two trees C and D, fig. 3, plate 5, be the objects to find their diſtance from each other, and the diſtance from the place of obſervation.—

vation.—Fix your inſtrument at A, and meaſuring in a ſtraight line to B, any diſtance, ſuppoſe 80 feet, then making your obſervation to B, draw a line for the line A B, and the lines for A C and A D; then ſcrew your index faſt on the line A B; move your inſtrument to B, turn your table till you ſee the mark at A; ſcrew your table faſt, and then take the lines B C and B D, ſo will they interſect in the points C and D: take off the paper of obſervation, and fixing it on the drawing-board with your T ſquare, lay down the lines, and taking from your ſcale of equal parts 80 foot, for the diſtance of A B; all the other diſtances may be meaſured with your compaſſes on the ſcale of equal parts, or the plotting ſcale.—In the ſame manner the diſtance of all objects either acceſſible, or inacceſſible, may be found.

PROBLEM V.

To meaſure the height of any building or tree.

LET the front of the houſe to be meaſured be A C, fig. 1, plate 5.—To take the height of any object, the table muſt be fixed on the ball and ſocket, ſo as to place it vertically, and the ſpirit level on the upper edge to place it level, as fig. 2, plate 1, then meaſuring any diſtance from the object, as ſuppoſe 100 foot; place your table as at B, making the upper edge level; move your index to the level mark on the table, and ſcrewing it faſt, draw the level line (a) from which line all the other lines form the angles;

and marking the building where that level line cuts, ſhews how high the building is to that mark from the ground; and having drawn all the lines on your table for the height of the windows, or what elſe you deſire to know; take off your paper of obſervation, place it on your drawing board, and with the T ſquare draw your level line a ~~A~~ B; and on the end A, erect the perpendicular A C; ſo will all the other lines give the heights required on the line A C, which is plain to be ſeen by inſpection.—The height of any tree is taken in the ſame manner; but to meaſure it for timber, it ſhould be taken no higher than where it may ſuppoſe to girt ſix inches, as fig. 2, plate 5.

PROBLEM VI.

To meaſure the height of any hill, or mountain, acceſſible, or inacceſſible, as fig. 4, plate 5.

HAVING placed your table near the foot of the hill, ſo as to ſee the top, your table being vertical, draw the level line, and take your angle line A B, then move your table back from A to E in a ſtraight line, which meaſure as ſuppoſe 60 equal parts; make your ſecond obſervation, the table being level, and take E B for your angle line, which will interſect the line A B in the vertical point B, which being laid down on your drawing board, draw the perpendicular line C B, which will be

the

the height of the hill, adding the height of the inſtrument from the ground.

PROBLEM VII.

To lay down or trace any figure, regular or irregular.

FIRST, on a half ſheet of paper, draw your figure, as ſuppoſe a regular hexagon, as fig. 7, plate 3, each ſide equal to 30 feet; then placing it on your drawing-board, and the paper to cover your table, draw a circle to the width of your index; and then with your T ſquare, draw the lines 1.2.3.4.5.6; ſo will you have all the ſides of the hexagon on your paper of obſervation, which fixing to your table, it is then ready for the tracing; having fixed on the ſpot where you intend to lay down the figure, place your table as ſuppoſe at A, fig. 8; begin with the lines 1 and 2, which mark on the ground, meaſuring the length of the ſides, viz. 30 feet, and then ſetting up marks as at AB and AF; then ſcrewing your index faſt on the line 1, move your table to the mark B, and turning it till through the ſights you obſerve the mark at A; ſcrew faſt your table, and turn your index to the line 3, and then mark that ſide alſo, and ſo proceed till you have marked all the lines; ſo will you have the exact figure on the ground as drawn on your paper.

PROBLEM VIII.

To inlarge or diminiſh any plan, or to copy any ſtraight line figure.

HAVING placed your plan on a drawing-board by itſelf, (if large) and the paper on which you intend to make the alteration on another; with your T ſquare begin with any ſide, and chuſing your ſcale (either to enlarge or diminiſh) ſet off the length of the firſt line taken, and ſo proceed till you have finiſhed your plan, which, with care, will be exact in proportion; this is ſo plain, it needs no example.

PROBLEM IX.

AS it is very requiſite in all ſurveys to have the meridian of the place laid down on the plan or map, which meridian may be found two ways.

Firſt. Having a ſmall box compaſs, as fig. 3, plate 1, place it on one ſide of your table as at A, before you begin your work, and turn your table till that ſide is due north and ſouth, which mark with a parallel line on your paper as b, which when laid down on your plan, will be the meridian required.

Secondly. If at any time during your ſurvey, the ſun ſhines, turn your index till the thread of your ſight ſhadows in the middle of your index, and draw a line as at fig. 1, plate 1; and at the ſame time, take the hour of the day by your

watch,

watch, and minute it down in your book; when you take off your paper of obſervation, draw that line for a diameter of a circle, as fig. 5, plate 1; take from the plain ſcale with your compaſſes the chord of 60, and draw the circle N E S W; then ſetting off to your right hand if the obſervation was before noon, and on the left hand if it was afternoon (as ſuppoſe in this obſervation one o'clock) 15 degrees, taken from the line of chords, and draw the line S N for the meridian required.

N. B. That you allow for every hour before or after twelve o'clock 15 degrees, and ſo in proportion for the parts of an hour.

PROBLEM X.

This table may be made uſe of as a quadrant, to the greateſt exactneſs, and with leſs trouble, as fig. 6, plate 1.—A, is a braſs ſlider, which draws out to any degree of elevation from 1 to 50; and by ſcrewing it faſt to the elevation required, the line B is raiſed or depreſs'd till the buble A is in its center; then is the line B to the elevation required; which will be found preferable to the plummet,

CHAP. VI.

A Table of Purchaſe, at ſeveral Rates of compound Intereſt allowed on both Sides, carefully corrected.

Years to be purchaſed.	5 per cent.			6 per cent.			7 per cent.			8 per cent.			9 per cent.			10 per cent.		
	Y.	M.	D.	Y.	M.	D.	Y.	M.	D.	Y.	M.	D.	Y.	M.	D.	Y.	M.	D.
1	0	11	12	0	11	9	0	11	6	0	11	3	0	11	0	0	10	27
2	1	10	9	1	10	0	1	9	20	1	9	11	1	9	3	1	8	24
3	2	8	20	2	8	2	2	7	14	2	6	27	2	6	11	2	5	25
4	3	6	16	3	5	17	3	4	19	3	3	22	3	2	26	3	2	1
5	4	3	28	4	2	16	4	1	6	3	11	27	3	10	20	3	9	14
6	5	0	27	4	11	0	4	9	5	4	7	14	4	5	24	4	4	7
7	5	9	13	5	6	29	5	4	20	5	2	14	5	0	11	4	10	12
8	6	5	16	6	2	15	5	11	19	5	8	28	5	6	12	5	4	0
9	7	1	8	6	9	18	6	6	5	6	2	28	5	11	28	5	9	3
10	7	8	19	7	4	9	7	0	8	6	8	15	6	5	0	6	1	22
11	8	3	20	7	10	19	7	5	29	7	1	20	6	9	19	6	5	28
12	8	10	10	8	4	18	7	11	9	7	6	12	7	1	27	6	9	22
13	9	4	21	8	10	6	8	4	8	7	10	25	7	5	25	7	1	7
14	9	10	23	9	3	16	8	8	28	8	2	27	7	9	13	7	4	12
15	10	4	16	9	8	16	9	1	8	8	6	21	8	0	21	7	7	8
16	10	11	1	10	1	8	9	5	10	8	10	6	8	3	22	7	9	26
17	11	3	8	10	5	21	9	9	4	9	1	13	8	6	15	8	0	7
18	11	8	8	10	9	27	10	0	21	9	4	13	8	9	2	8	2	12
19	12	1	0	11	1	26	10	4	0	9	7	7	8	11	12	8	4	11
20	12	5	16	11	5	19	10	7	3	9	9	24	9	1	16	8	6	4
21	12	9	25	11	9	5	10	10	0	10	0	6	9	3	15	8	7	23
22	13	1	28	12	0	14	11	0	22	10	2	12	9	5	9	8	9	7
23	13	5	25	12	3	19	11	3	7	10	4	13	9	6	28	8	10	17
24	13	9	17	12	6	18	11	5	18	10	6	10	9	8	14	8	11	24
25	14	1	3	12	9	12	11	7	25	10	8	2	9	9	26	9	0	27
26	14	4	15	13	0	1	11	9	27	10	9	21	9	11	4	9	1	27
27	14	7	21	13	2	15	11	11	25	10	11	6	10	0	9	9	2	25
28	14	10	13	13	4	26	12	1	19	11	0	18	10	1	11	9	3	20
29	15	1	20	13	7	2	12	3	9	11	1	27	10	2	11	9	4	13
30	15	4	14	13	9	5	12	4	27	11	3	2	10	3	8	9	5	3
31	15	7	3	13	11	4	12	6	11	11	4	5	10	4	3	9	5	22
61	18	11	22	16	2	8	14	0	19	12	4	18	11	0	19	9	11	19
99	19	10	2	16	7	11	14	3	6	12	5	27	11	1	9	9	11	29

	Y.	M.	D.
By this Table, a yearly Rent for 25 Years to come at 5 per Cent. is worth in ready Money, — —	14	1	3
But to renew (ſuppoſe) a Leaſe of 21 Years at 5 per Cent. whereof 7 Years are elapſed,—from the Value of the Leaſe, or 21 Years,	12	9	25
ſubſtract the Value of the unexpired or 14 Years, —— ——	9	10	23
Remains the Value of the Renewal or Rent to be paid	2	11	2

A Table of the Decimal Fraction from one Day to thirty, and from one Month to eleven,— a Year being the integer or whole Number.

Months.	
1	,0834
2	,1667
3	,25
4	,3334
5	,4167
6	,5
7	,5834
8	,6667
9	,75
10	,8334
11	,9167

Days.	~~Whole Numbers.~~ Decl. Fraction
1	,0028
2	,0055
3	,0082
4	,011
5	,0137
6	,0165
7	,0192
8	,022
9	,0246
10	,0274
11	,03
12	,033
13	,0356
14	,0382
15	,0411
16	,044
17	,0466
18	,05
19	,0521
20	,0548
21	,0575
22	,06
23	,063
24	,066
25	,069
26	,071
27	,074
28	,0768
29	,08
30	,0822

The uſe of the foregoing table is for the more ready caſting up the purchaſe, as found in the purchaſe table.

EXAMPLE I.

To find the Value of a Leaſe or Annuity of 5l. per annum, whereof 30 Years is unexpired, at 5 per cent. compound Intereſt.

	Y.	M.	D.
By the table the value is found to be	15	4	14

First ſet down 15,0000 for years
,3334 for 4 months
,0382 for 14 days

15,3716
5 ~~per cent.~~ per ann.

76,8580
20

17,160
12

1,92 nearly two-pence

Value found is £76 17s. 2d.

EXAMPLE II.

To find what ſum per ann. muſt be received for any ſum given for a term of years, (ſuppoſe 30) at 5l. per cent. which by the table is found to be 15 years, 4 months, 14 days.

Let the ſum given be 76l. 17s. 2d.

The Rule: reduce the ſum given into the loweſt denomination for a dividend, and the purchaſe time into decimals for a diviſer; the quotient will be the annual ſum required,

That is — — £76 17s. 2d.
20
15 Years 15,0000 ———
4 months ,3334 1537
14 days ,0382 12
——— ——— 12)
15,3716)18446,0000(—1200,
153716 ———
——— 2|0) 10|0
307440 ———
307432 5—
——— ———
8
—

Answer 5l. per annum.

The Characters or Signs made uſe of in Arithmetic are theſe.

=	Equal	that is	$a=b$	or	$3=3$
+	Addition, or more		$a+b$		$3+6=9$
—	Subſtraction, or leſs		$b-a$		$6-3=3$
×	Multiplication		$a\times b$		$3\times 6=18$
÷	Diviſion		$b\div a$		$6\div 3=2$

is to ſo is to

: : : : Proportion - as $a : b :: c : d$

that is - as $3 : 6 :: 4 : 8$

F I N I S.

BRITISH 22 MY 90 MUSEUM

21A

Plate. 1.

Fig. 1.

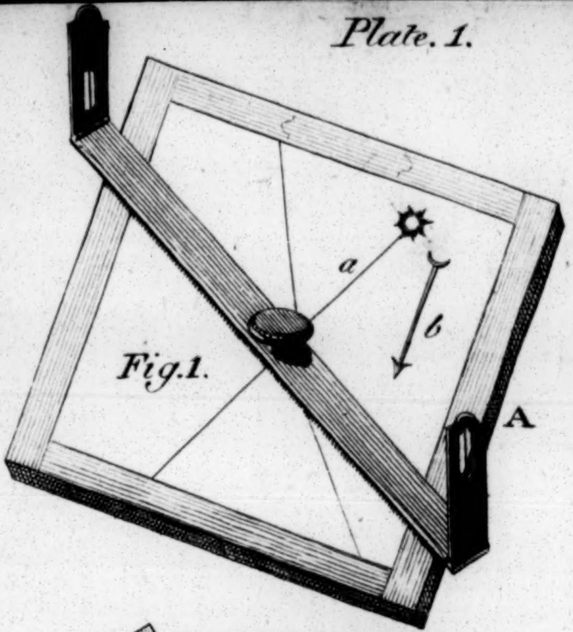


Fig. 3.

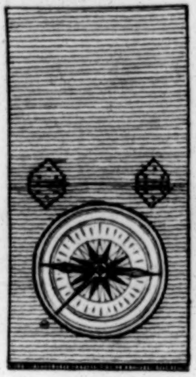


Fig. 2

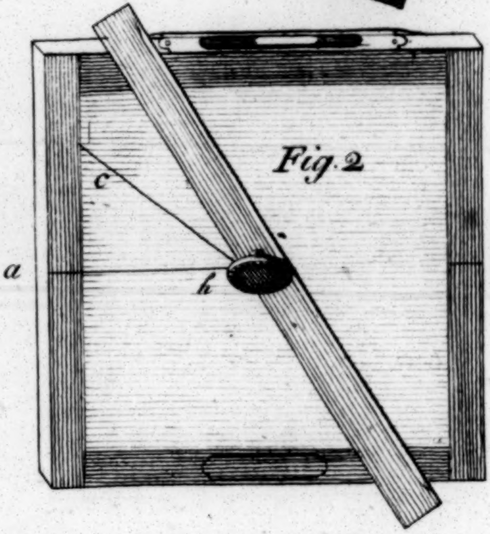


Fig. 4.

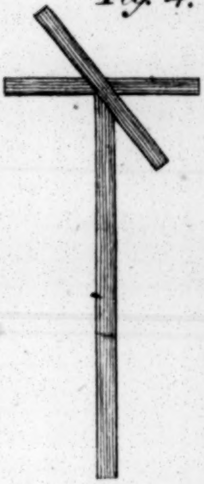


Fig. 5.

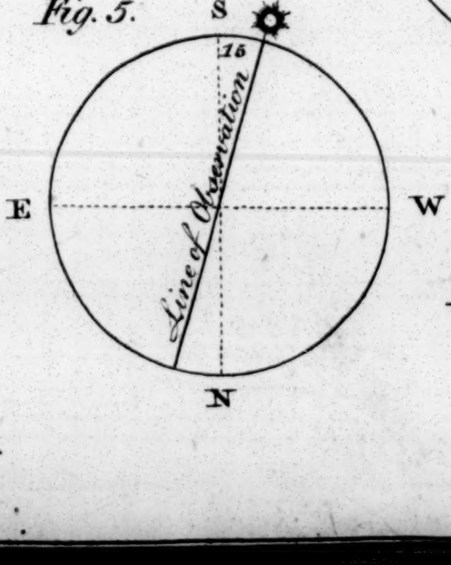
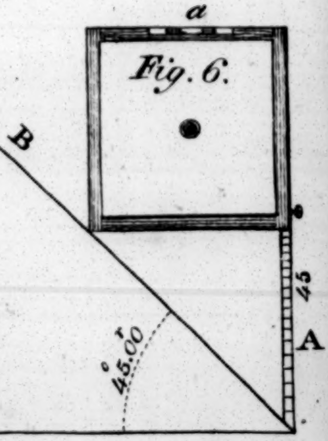


Fig. 6.



BRITISH
22 MY 90
MUSEUM

Plate 2.

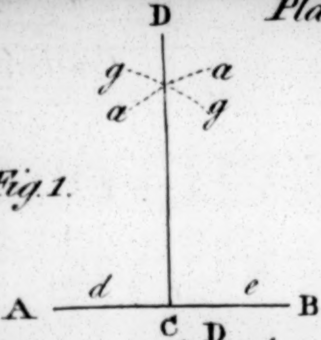


Fig. 1.

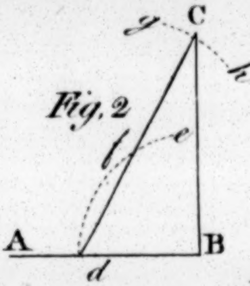


Fig. 2

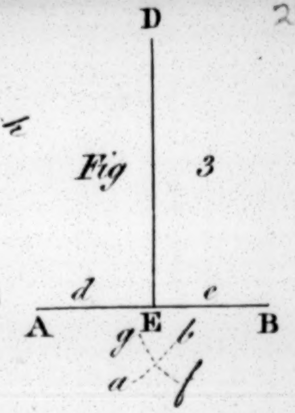


Fig 3

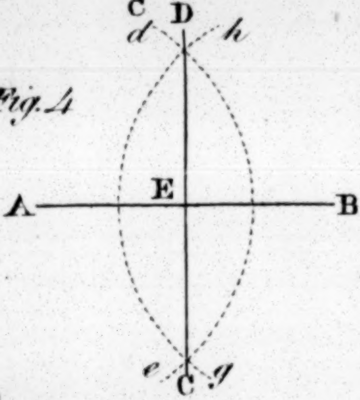


Fig. 4

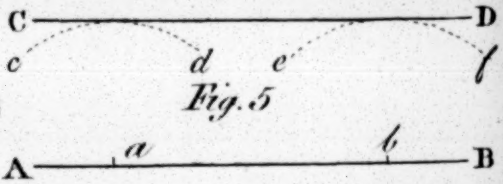


Fig. 5

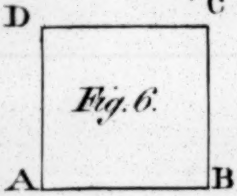


Fig. 6.

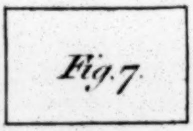


Fig. 7

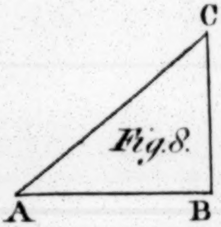


Fig. 8.

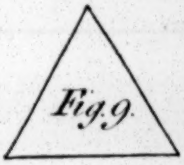


Fig. 9.

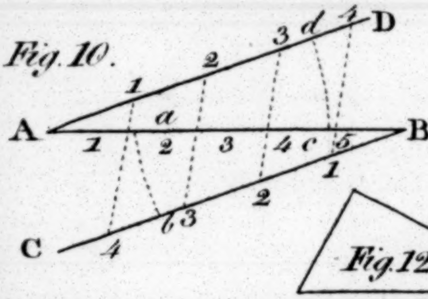


Fig. 10.

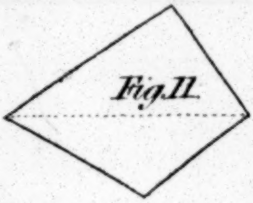


Fig. 11.

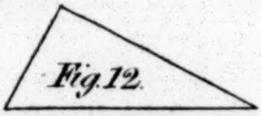


Fig. 12.

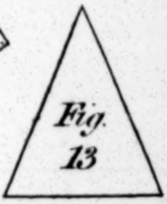


Fig. 13

Scale of Equal Parts

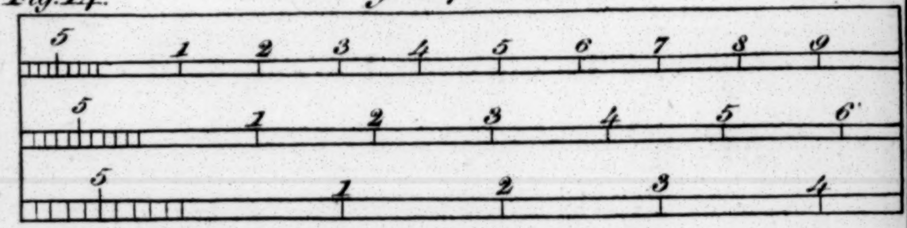


Fig. 14.

Plotting Scale.

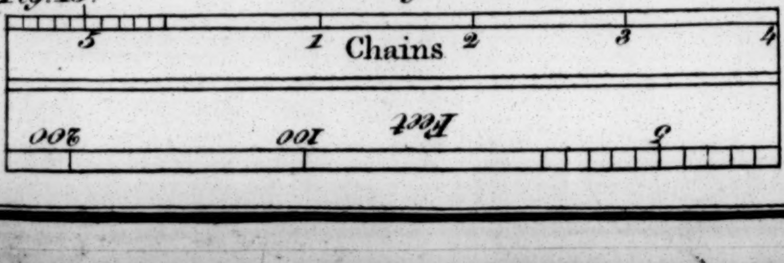


Fig. 15.

BRITISH
23 MY 96
MUSEUM

Plate 3

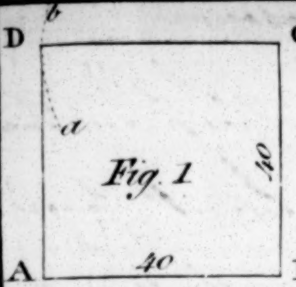


Fig. 1

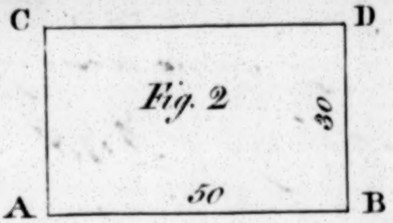


Fig. 2

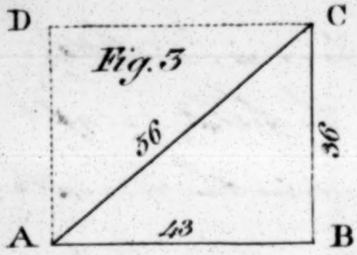


Fig. 3

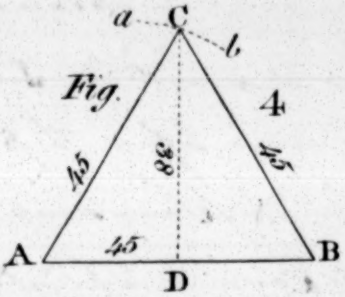


Fig. 4

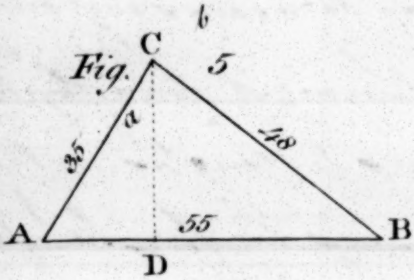


Fig. 5

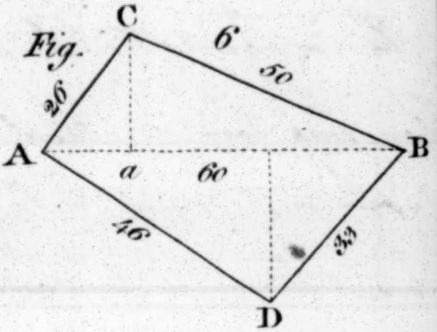


Fig. 6

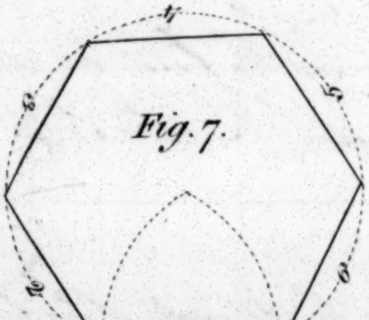
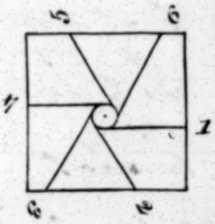


Fig. 7



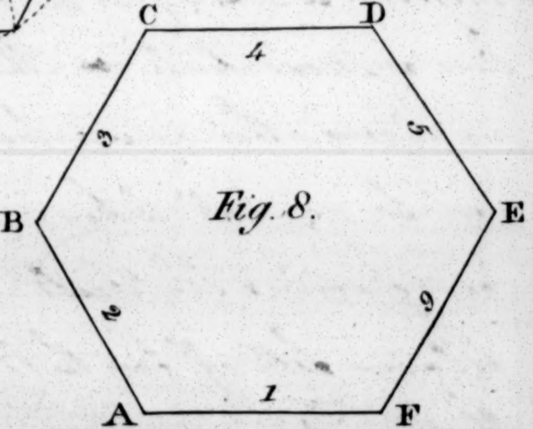
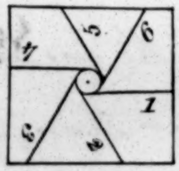


Fig. 8



This is all exactly copied from Leybourn

See the very same description of the Plain Table in Dictionary of A & S - under Letter P - page 244

Only there the plan is formed on the Spot but here it is not —— Indeed there is but little occasion to form the plan in the field, except when the plain Table is fixed in the Middle of the Field to take it from One or Two Stations then a hand Sketch may be necessary Enough

Therefore this method of laying it down by the angles only and entering the lengths in the Field Book is the best way by far See Leybourn 244

The best way is to go round the field as close to the hedges as possible then the Setts off will be Short

BRITISH MUSEUM 22 MY 90

If the plan is taken from the Middle of the field by One or More Stations - the Bends - gates and various other remarks in the hedges can not be so well taken as by the method of going round the Field —— you then take all your Setts off from the Chain while it lyes on the ground as you are measuring the Sides from Angle to Angle. G Baker October 5th = 1790

Plate 4

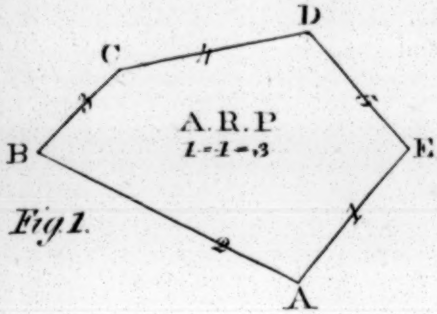
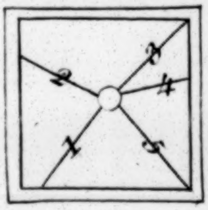


Fig.1.

Fig. 2



Drawing Board

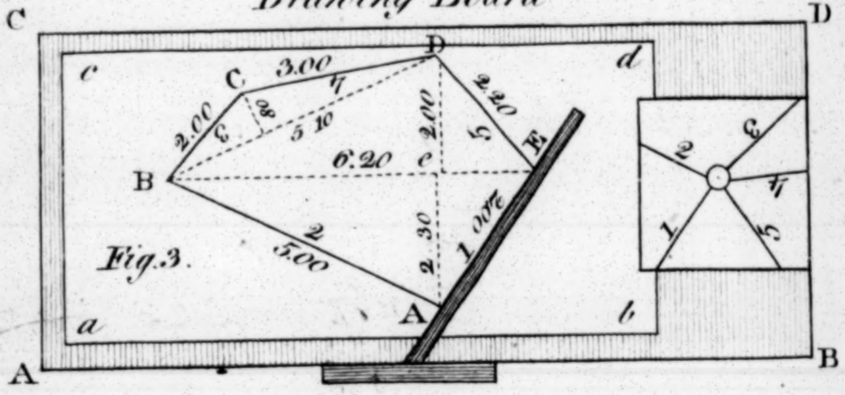


Fig.3.

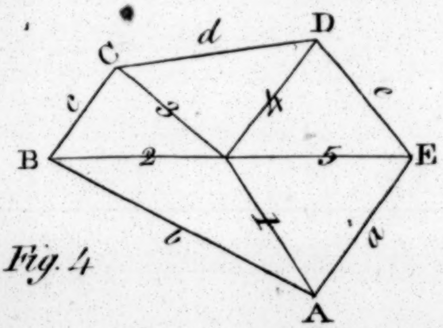
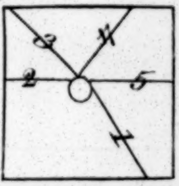
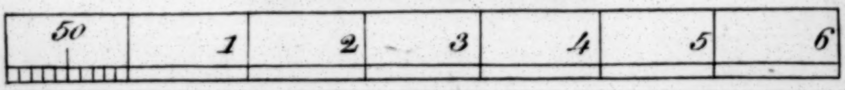


Fig. 4

Fig. 5.



A Scale of Six Chains



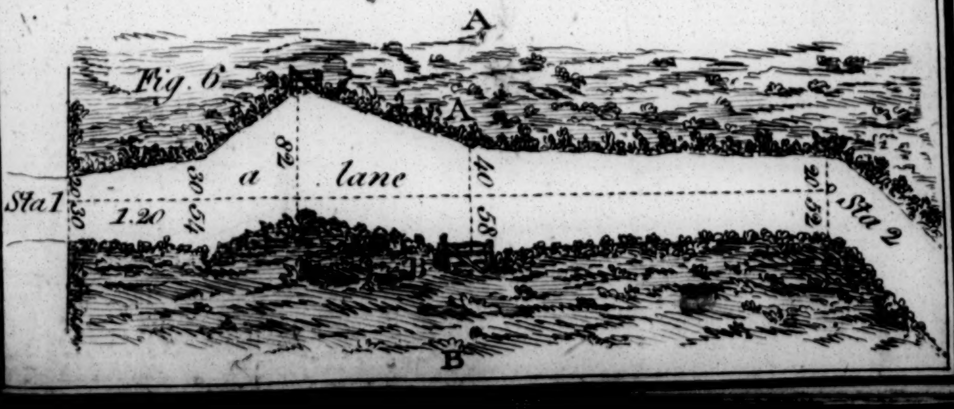


Fig. 6

BRITISH
22 MY 90
MUSEUM

Plate. 5.

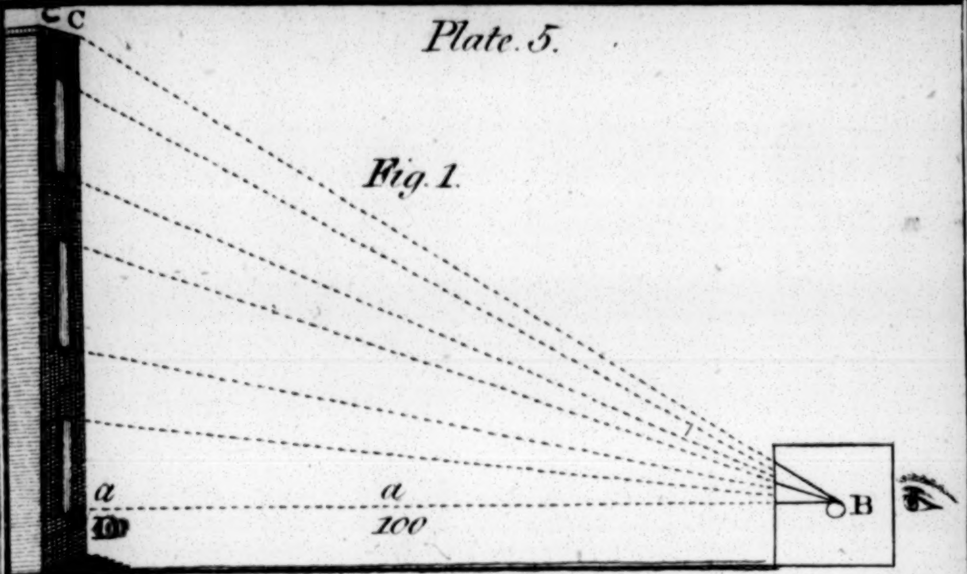


Fig. 1.

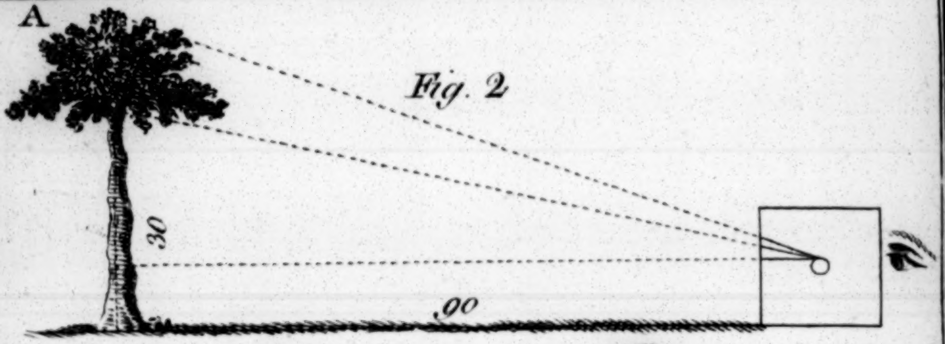


Fig. 2

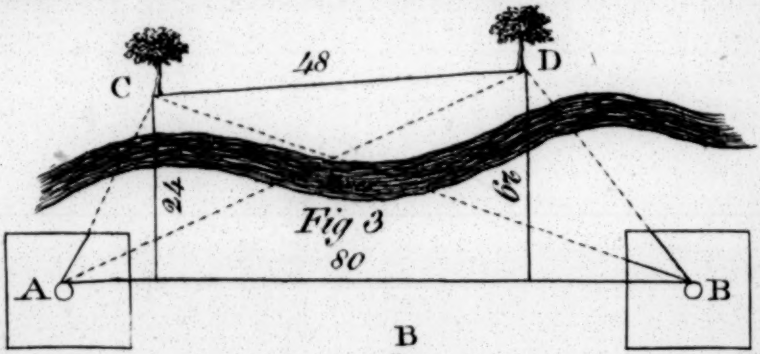


Fig 3

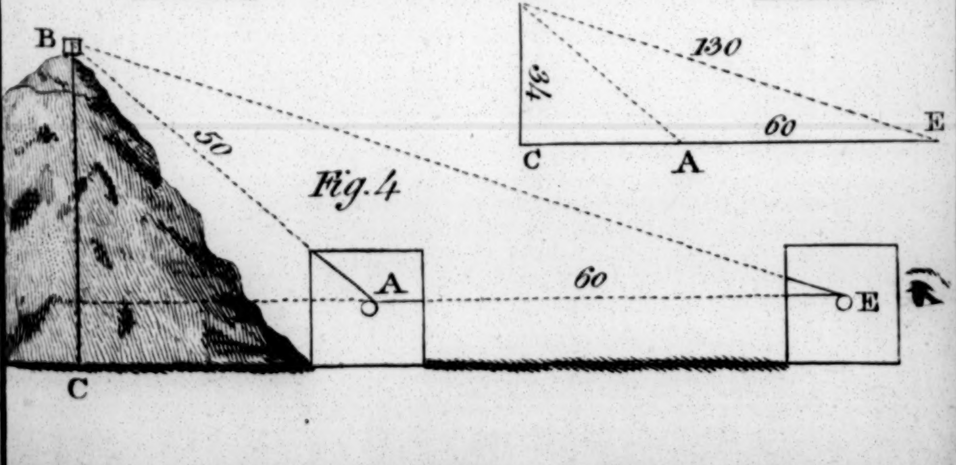


Fig. 4